Task	Milestones	Due Dates	POC/ Lead
Benchmark Q3FY16 GDAS/GFS on Cray (v13.1.0)	• Port all components of Q3FY16 GDAS/GFS to Cray • Conduct 3-month cycled tests to confirm comparable results to pr4devb (control)	• April 1, 2016 • May 1, 2016	Nicole McKee
Transition and benchmark NEMS/GSM on Phase 2 (v14.0.0)	• Transition all components of Q3FY16 GDAS/GFS to NEMS/GSM • Conduct 3-month forecast only tests to confirm acceptable results compared to pr4devb • Conduct 3-month fully cycled tests to confirm comparable results to pr4devb	• April 1, 2016 • May 1, 2016 • May 15, 2016	Fanglin Yang
Port and benchmark NEMS/GSM on Cray (v14.1.0)	• Port all components of v14.0.0 to Cray • Conduct 3-month fully cycled tests to confirm comparable results to pr4devb • Run the parallel end-to-end system in real-time	• April 15, 2016 • May 1, 2016 • May 15, 2016	Lin Gan

NEMS Transitions

- Development of GFS (non-NEMS) frozen soon after porting to Cray (task 1)
- All developers migrate to NEMS/GSM framework by May 1, 2016
- V14.1 forms the control configuration for FY17 GFS/GDAS implementation
- Scripting & workflow changes to address the needs

Potential Science upgrades for FY17 NEMS GSM/GDAS

- Resolution; Physics, Data Assimilation;
- Products/Downstream Changes
- Resource Requirements
- Test Plan and execution

- **Need inputs by March 21, 2016**
- **Charter and Project Management established by April 1, 2016**
- **Briefing to Louis on April 4, 2016**

Plans for 2017: Transition to NEMS GSM

- NOAA Environmental Modeling System (NEMS) version of GFS using ESMF
- Global atmosphere divided into dynamics and physics components (easier to switch to NGGPS dynamics in the future)
- Using common write component outside of science components
- May use NUOPC physics driver if ready

Dynamics

- GSM with a two time-level Semi-Lagrangian Semi-implicit (SLSI) dynamics with a reduced linear transform grid.
- T2046 spectral resolution: 4096x2048 (~ 9.8 km near the equator)
- Vertical: Either 64 or 91 or 128 hybrid σ – p layers.
- Time step – 450s
- Reference pressure – 101350 Pa for stable two-time level semi-implicit scheme – reduced divergence damping

Possible Physics Options

- Simplified Higher Order Closure (SHOC) sub-grid scale turbulence with prognostic TKE & Unified deep convection (Chikira-Sugiyama with Arakawa-Wu scale-aware extension) – OR –
- Scale- & aerosol-aware deep & shallow convection schemes with convective cloudiness enhancement
- Improving the interactions of cloud macrophysics, microphysics, and radiation
- Double-moment cloud microphysics scheme
- Improved land surface modeling

Q2FY17 NEMS/GSM

- **Global Spectral Model Resolution and Physics:**
  - Various options (T1534 L91/L128; T2046 L91)
  - Update Rayleigh damping and divergence damping to improve forecast in the upper stratosphere (Fanglin Yang and Moorthi)
  - Scale- & aerosol-aware deep & shallow convection schemes with convective cloudiness enhancement (Jongil)
  - TKE based EDMF parameterization of moist boundary layer turbulence (Jongil)
  - Add MPIIO in write grid component (Jun Wang)
- **Land Surface Model:**
  - Use high resolution(1km) IGBP vegetation and STASGO soil type data to replace current coarse resolution (1 degree) UMD/Zolber. (Helin Wei)
  - Use high resolution MODIS snow and snow free albedo to address the cold bias over snow. (Helin Wei)
  - Add decoupling prevention to address the rapid temperature drop during sunset. (Weizhong Zheng)
  - Use standalone GLDAS forced by observed precipitation to provide initial land states to GSM. (Jesse Meng and Helin Wei)

Q2FY17 NEMS/GSM

- **<u>Sea Ice:</u>**
  - Using 15% as a cutoff for sea ice concentration to represent sea ice cover; it is more realistic, and consistent between the coupled and uncoupled case (Xingren Wu)
- **<u>SST:</u>**
  - Turn on the NSST (Near-Surface Sea Temperature), which has been built in GSI and NEMS/GSM. It leads to a better ocean and better use of satellite data in NWP. The impact on weather prediction is neutral to positive.
- **<u>Terrain/Lakes:</u>**
  - Use new USGS GMTED2010 terrain data, which is the replacement for the USGS GTOPO30 data. (George Gayno)
  - As model resolution increases, more small lakes will be resolved. Need to ensure the temperature and ice content of these small lakes can be accurately specified. (George Gayno)

Q2FY17 NEMS/GSM

- **<u>Post:</u>**
  - Use NCEPPOST to read nemsio flux files in binary format and write out flux files in grib2 to save disk space (Huiya Chuang)
  - Add to NCEPPOST the computation of vertical velocity using gridded data as input. (Huiya Chuang)
- **<u>Products:</u>**
  - Output number concentration and mixing ratio of cloud liquid, cloud ice, rain, and snow if there is not such output including convective clouds.
  - Output TKE for diagnostic purpose. Large TKE in PBL will prompt surface latent and sensible heat fluxes, influencing both the surface and near surface 2m and 10m temperature. TKE in the free troposphere directly links to cloud production and dissipation if SHOC is in GSM/NEMS (Anning Cheng)

Q2FY17 NEMS/GDAS

Data Assimilation:

1. ***Radiance Assimilation***
   - Near Sea Surface Temperature (NSST)
   - CrIS Full spectral Resolution data and generalization of hyperspectral sounder reading capability
   - Modification to Megha-Tropiques SAPHIR QC (positive impact on upper Trop. humidity analysis/forecast)
   - Assimilation of VIIRS
2. ***AMV Assimilation***
   - VIIRS
   - GOES-R algorithm new BUFR for current satellites
   - Log-normal(wind) quality control
   - Turn AVHRR winds ON
3. ***Resolution and Configuration Changes:***
   - Analysis resolution TBD
   - IAU ??
   - Replace EnKF with LETKF ??

2015 AGU Fall Meeting, San Francisco, California, 14-18 December 2015

Reduction of NCEP Global Forecast System 2-m Temperature Forecast Errors

Weizhong Zheng[1,2], Michael Ek[1], Helin Wei[1,2] and Jesse Meng[1,2]

[1]NOAA/NCEP/EMC, College Park, MD 20740, USA; [2]IMSG at NOAA/NCEP/EMC, College Park, MD 20740, USA;

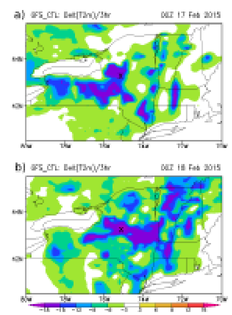
Contact information: Weizhong.Zheng@noaa.gov

1. Abstract

In this study the systematic deficiencies and cause of errors in 2-m temperature forecasts in the NCEP Global Forecast System (GFS) are identified by investigating the physics of the Noah land surface model and land-atmosphere interactions, and a practical solution is found to reduce this kind of forecast errors. This presentation focuses on further evaluation of the proposed modifications with two one-month experiments for summer and winter seasons through the verification of GFS forecasts against surface and sounding observations. It was found that the modifications can substantially avoid late afternoon rapidly dropping 2-m temperature and decoupling when a cessation of turbulent transport between the surface and the atmosphere due to high near surface atmospheric stability happens, and reduce the cold bias of 2-m temperature during nighttime. Furthermore, the surface dew point temperature, surface wind speed and scores for light and medium precipitation are also improved. In the future, new land data sets such as vegetation and soil types, near real-time green vegetation fraction and snow albedo will be updated and we expect further reduction of 2-m temperature bias in the GFS model.

2. Rapidly dropping of T2m in late afternoon

Initialed at 00Z, 16 February 2015, the GFS was performed a 7-day forecast. The rapidly cooling in some regions was clearly seen in late afternoon on February 17 and 18. Figures 1a,b give the 2-m temperature changes near the sunset for these two days, and Figure 1c gives the 2-m temperature time series at Utica station in New York from 00:00 UTC 16 to 19 February 2015.



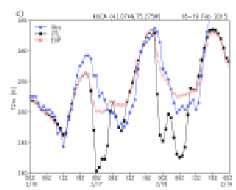


Fig.1 2-m temperature changes in CTL during 3 hours from 21 UTC, Feb. 16 to 00 UTC, Feb.17, 2015 (a) and from 21 UTC, Feb. 17 to 00 UTC, Feb.18, 2015 (b). (c) is 2-m temperature time series at Utica labeled with "X" in Figures 1a,b for observation (blue line), CTL (black line), and EXP(red line), during a period from 16 to 19 February, 2015.

3. Solution to prevent excessive cooling and decoupling

Due to high near surface atmospheric stability, a cessation of turbulent transport between the surface and the atmosphere may happen, so that the land and atmosphere coupling can not be solved as a function of external parameters or loss of predictability. In this study, excessive cooling and decoupling can be prevented by limiting the surface layer stability parameter. As shown in Figure 1c, the sensitivity test (EXP) with this approach substantially avoided rapidly dropping temperature and quite closed the observation. Figures 2a,b further present temperature variations at different levels for CTL and EXP, respectively.

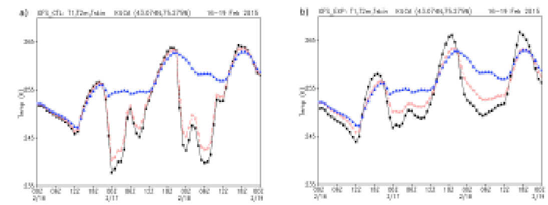


Fig.2 Time series of the first model level temperature (blue), surface skin temperature (black) and 2-m temperature at Utica for CTL (a) and EXP(b), during a period from 16 to 19 February, 2015.

4. Winter case

In order to examine the proposed modifications effect on GFS long time runs, more than one-month free forecasts with GFS were carried out for two seasons, respectively. The winter case starts from January 21 to March 02, 2015.

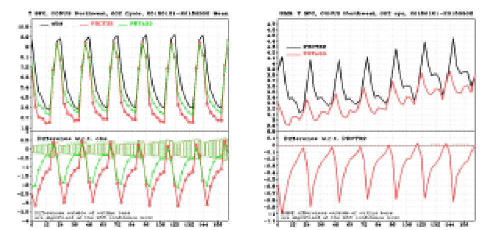


Fig.3 Comparison of 2-m temperatures for GFS tests averaged over a period from Jan. 21 to March 2, 2015 over the northwest CONUS. *Left:* 2-m temperatures for the observation (black line), CTL (red lines) and EXP (green lines); *Right:* RMSE for CTL (black line) and EXP (red line), and their differences with the statistical significance tests;

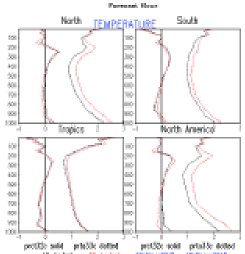


Fig.4 Temperature profiles verified against the sounding observation over the North Hemisphere, the South Hemisphere, Tropics and North America.

5. Summer case

As to the summer case, the GFS runs from August 15 to September 22, 2015, for control and sensitivity tests, respectively.

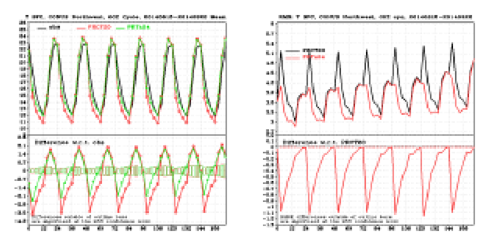


Fig.5 Comparison of 2-m temperatures for GFS tests averaged over a period from Aug. 15 to Sept. 22, 2014 over the northwest CONUS. *Left:* 2-m temperatures for the observation (black line), CTL (red lines) and EXP (green lines); *Right:* RMSE for CTL (black line) and EXP (red line), and their differences with the statistical significance tests;

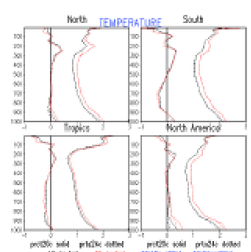


Fig.6: Temperature profiles verified against the sounding observation over the North Hemisphere, the South Hemisphere, Tropics and North America.

6. Precipitation skill scores over CONUS

Verification against the ground rainfall measurements over the CONUS precipitation forecast indicates the good impact of precipitation.

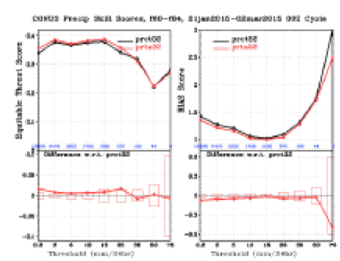


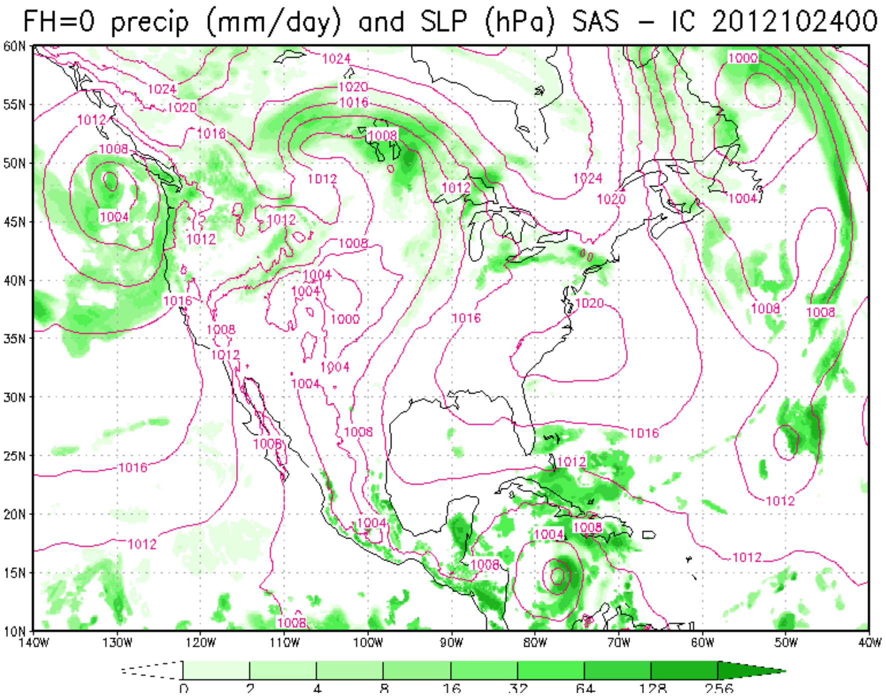
Fig. 7 Precipitation Equitable Threat Score (ETS) and bias score over CONUS for the winter case. Black lines denote CTL, red lines denote EXP and blue numbers denote observation stations. Lower panels indicate the statistical significance tests.

7. Summery and discussion

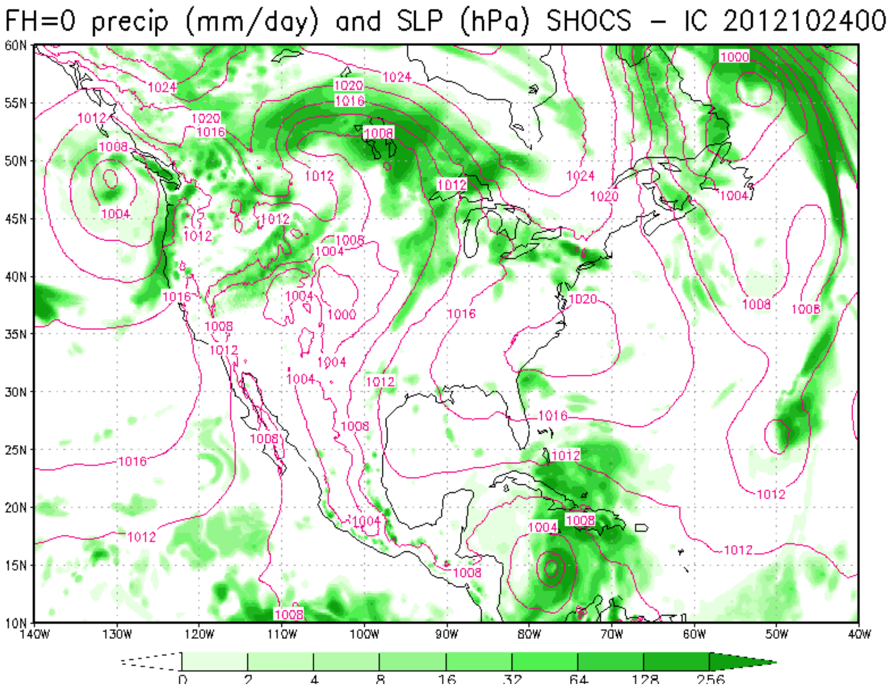
- **The GFS T2m cold bias was fixed with the proposed modifications, including updated the roughness length and preventing the land-atmosphere coupling system from decoupling;**
- **The case study over snow pack indicates the modifications can remove the large cold biases of T2m and surface skin temperature, and the first model level temperature was also improved.**
- **The tests for more than one-month GFS free forecasts in the winter and summer seasons demonstrate the modifications can substantially reduce the T2m errors in later afternoon and night-time;**
- **We plan to include the modifications in next upgrade operational GFS model in 2016.**

Simulation of Hurricane Sandy: Impact of resolution & physics

NEMS/GSM run at T2046: opr physics



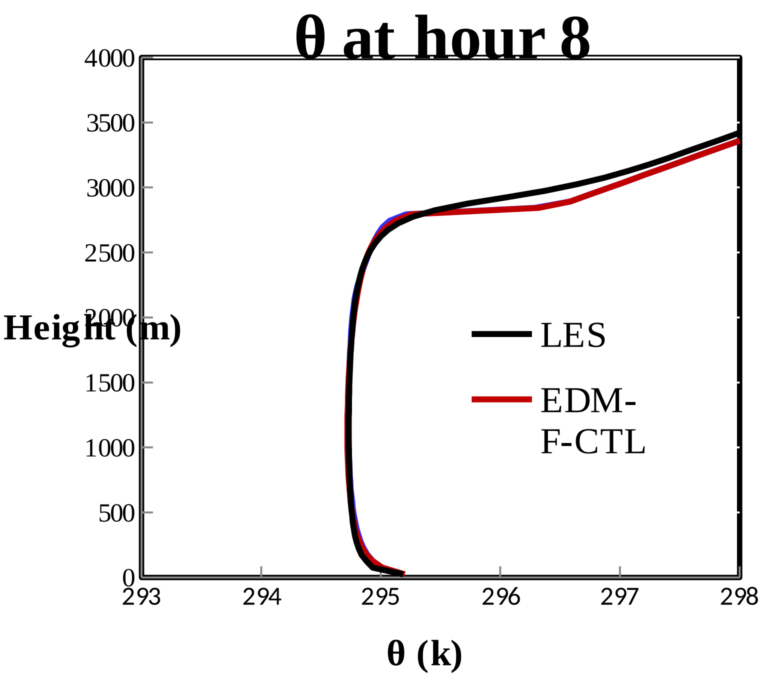
NEMS/GSM run at T2046: SHOC+CS



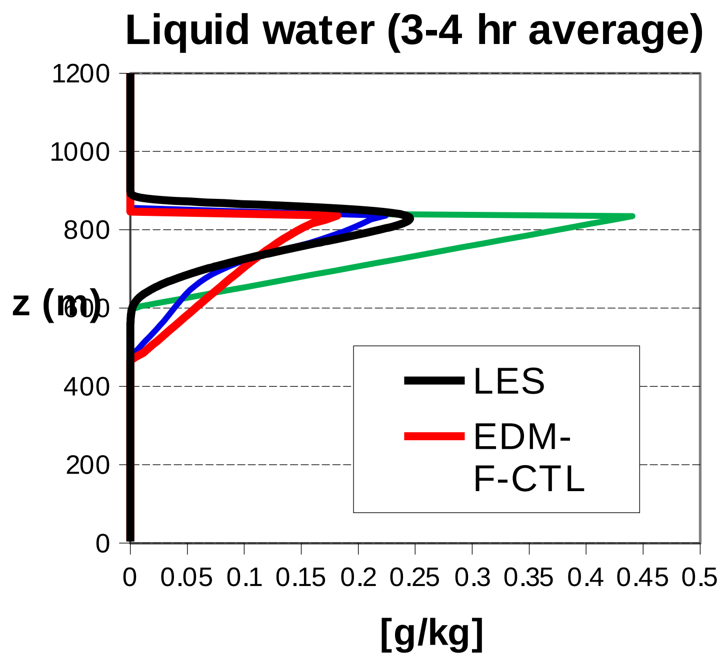
TKE-based EDMF Parameterization of Moist Boundary Layer Turbulence

Accomplishment Title: **A TKE-based Eddy-Diffusivity Mass-Flux (EDMF) Parameterization for Convective Boundary Layer (CBL) and Stratocumulus-top-driven Turbulence Mixing**

Single Column Model Test Results



CBL



Stratocumulus-topped Boundary Layer

TKE-based EDMF Parameterization of Moist Boundary Layer Turbulence

Key Take Away Message

- A TKE-based EDMF planetary boundary layer (PBL) scheme has been developed and successfully simulates daytime well-mixed CBL with a good agreement with the LES result.
- For the CBL, the new TKE-based EDMF PBL scheme predicts a PBL feature very similar to that from the current operational GFS hybrid EDMF PBL scheme (which is based on first-order K-profile method).
- Compared to the LES result, the new scheme also well simulates the marine stratocumulus-topped boundary layer, showing somewhat better prediction than the operational one.